

Appendix D

Relationship Between Surface and Subsurface Contaminant of Concern Concentrations

1 Introduction

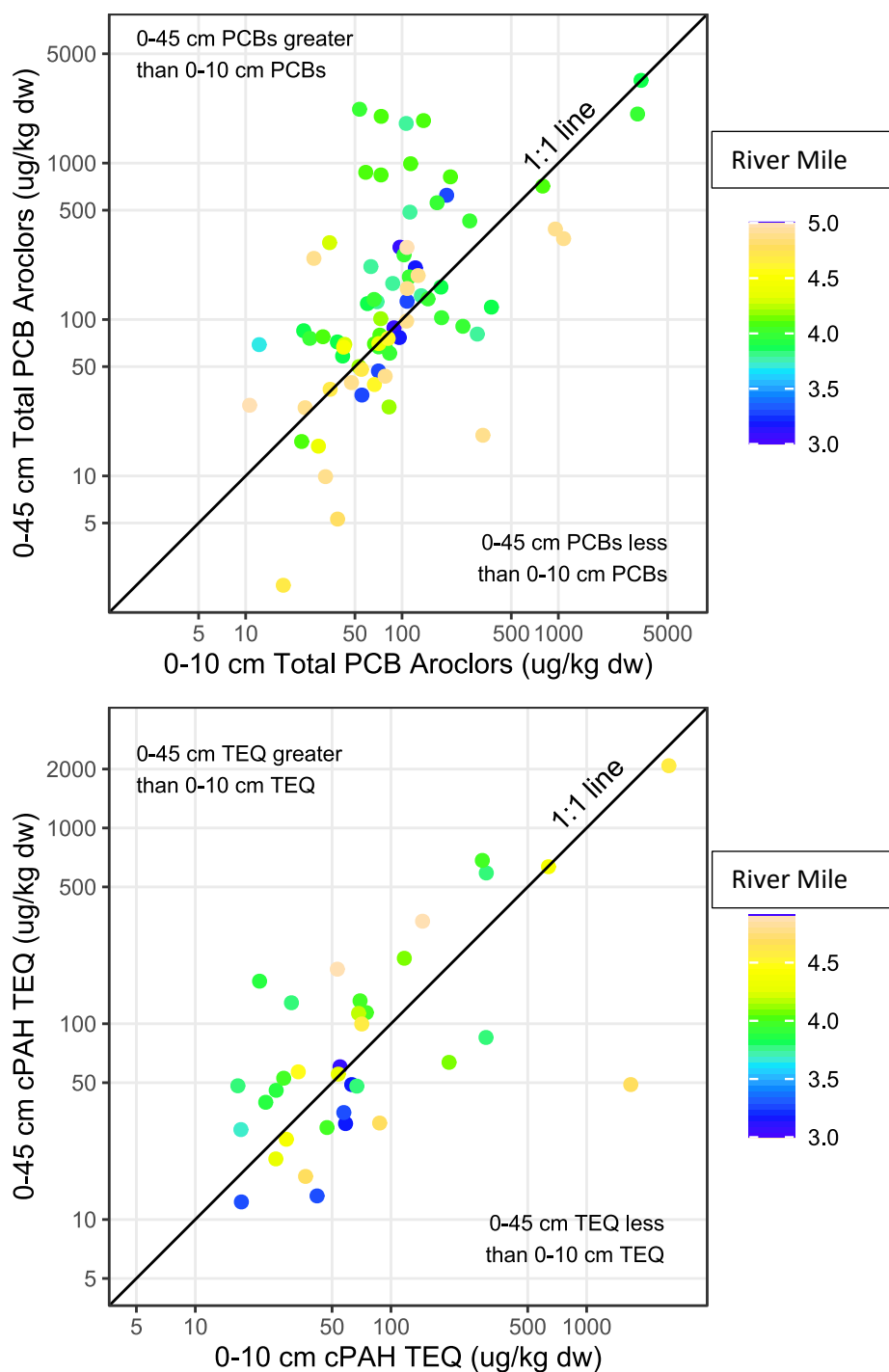
This appendix was prepared to address a US Environmental Protection Agency (EPA) request to compare surface and subsurface sediment contaminant of concern (COC) concentrations in upper reach locations (river mile [RM] 3.0 to RM 5.0) in the Lower Duwamish Waterway (LDW) Phase I Pre-Design Investigation (PDI). The Phase I data were used to compare COC concentrations in surface sediment (0–10 cm) and subsurface sediment (0–45 cm or 0–60 cm) at all locations where both surface and subsurface sediment samples were collected. Samples were co-located if they were collected at the same location and the surface grab and core were collected within 10 ft of one another. Comparisons were made using four human health risk drivers: total polychlorinated biphenyl (PCB) Aroclors, carcinogenic polycyclic aromatic hydrocarbon (cPAH) toxic equivalents (TEQs), dioxin/furan TEQs, and arsenic.

2 Comparison of Surface Sediment (0–10 cm) to Subsurface Intertidal Sediment (0–45 cm)

The PCB concentrations and cPAH TEQs for surface sediment and subsurface intertidal sediment are compared in Figure D-1. The two datasets (0–10 cm and 0–45 cm) are significantly correlated for both COCs (non-parametric Spearman's rank correlation, $p < 0.001$ for each). The results are distributed above and below the 1:1 line, indicating that there was no consistent bias for the surface concentrations to be greater or less than the subsurface concentrations. Samples within the same river mile were distributed above and below the 1:1 line, indicating no clear spatial trend. Similar results are shown for dioxin/furan TEQ values and arsenic concentrations (Figure D-2), with significant correlations within both datasets (non-parametric Spearman's rank correlation $p < 0.001$).

Figure D-1

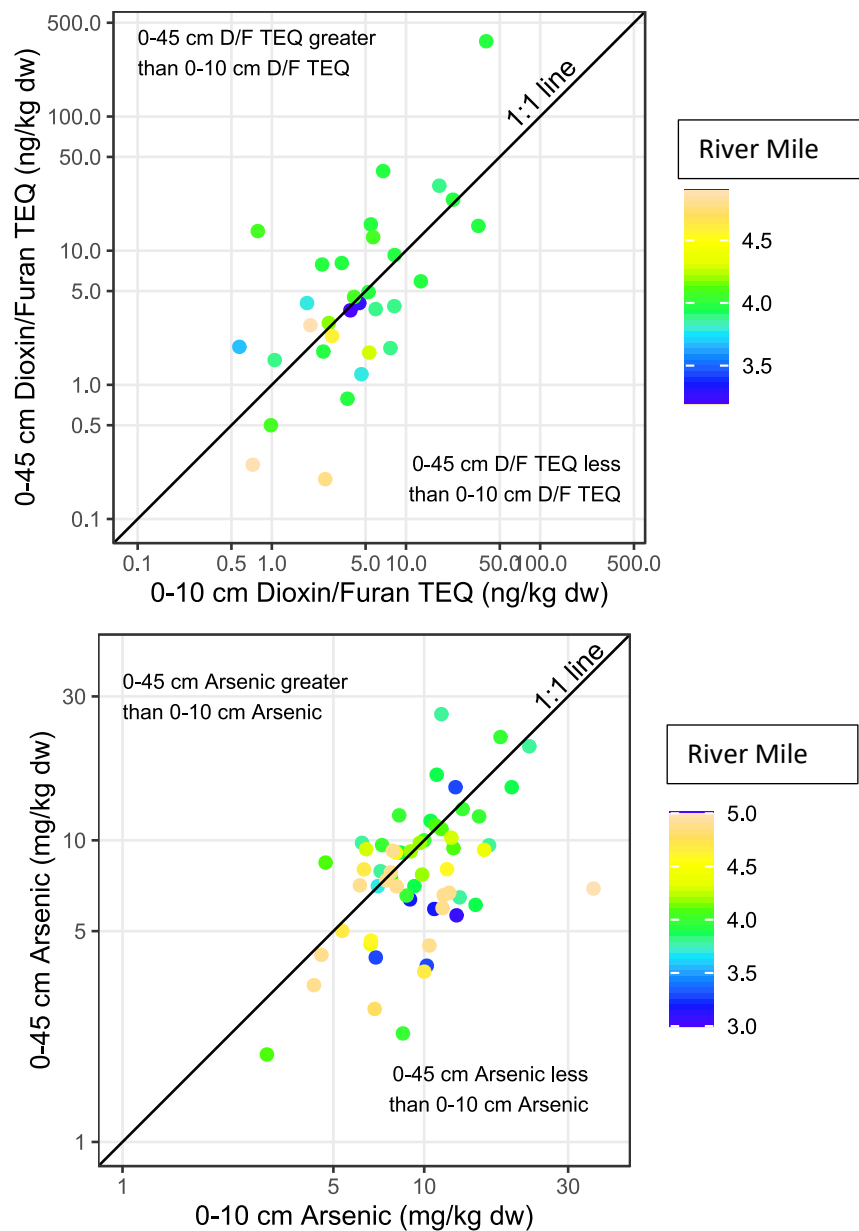
Scatterplots of Total PCBs and cPAH TEQ Values in Surface (0–10 cm) Versus Subsurface Sediment (0–45 cm) in the Intertidal



Points color coded by river mile. Black line is the 1:1 line – points above this line have subsurface concentrations greater than those in the surface.

Figure D-2

**Scatterplot of Dioxin/Furan TEQ Values and Arsenic Concentrations in Surface (0–10 cm)
Versus Subsurface Sediment (0–45 cm) in the Intertidal**



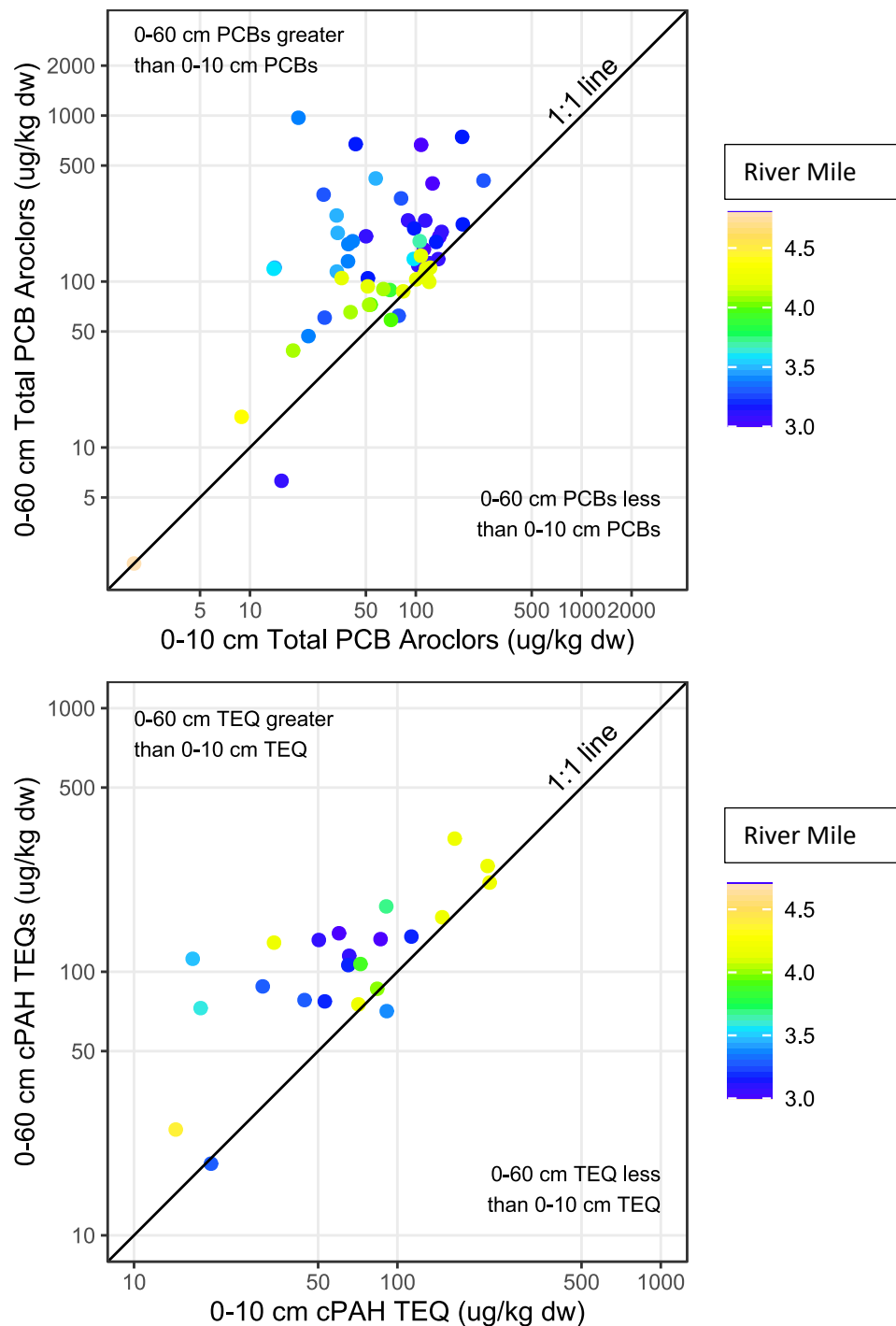
Points color coded by river mile. Black line is the 1:1 line – points above this line have subsurface concentrations greater than those in the surface.

3 Comparison of Surface Sediment (0–10 cm) to Subsurface Sediment (0–60 cm) in the Subtidal

PCB concentrations and cPAH TEQs in subtidal subsurface sediment (0–60 cm) were similar to or greater than concentrations in surface sediment (0–10 cm) (Figure D-3). These correlations were statistically significant (Spearman's rank correlation $p < 0.005$). The majority of the sampling locations plot above the 1:1 line, indicating that the 0–60-cm subsurface sediment PCB concentrations and cPAH TEQs tend to be greater than the surface sediment results. The data were insufficient to adequately assess the relationship for dioxin/furan TEQs (Figure D-4), whereas arsenic had no consistent tendency for surface sediment concentrations to be greater or less than subsurface sediment concentrations in the subtidal samples (Figure D-4). This correlation was also statistically significant (with Spearman's rank correlation $p < 0.005$).

Figure D-3

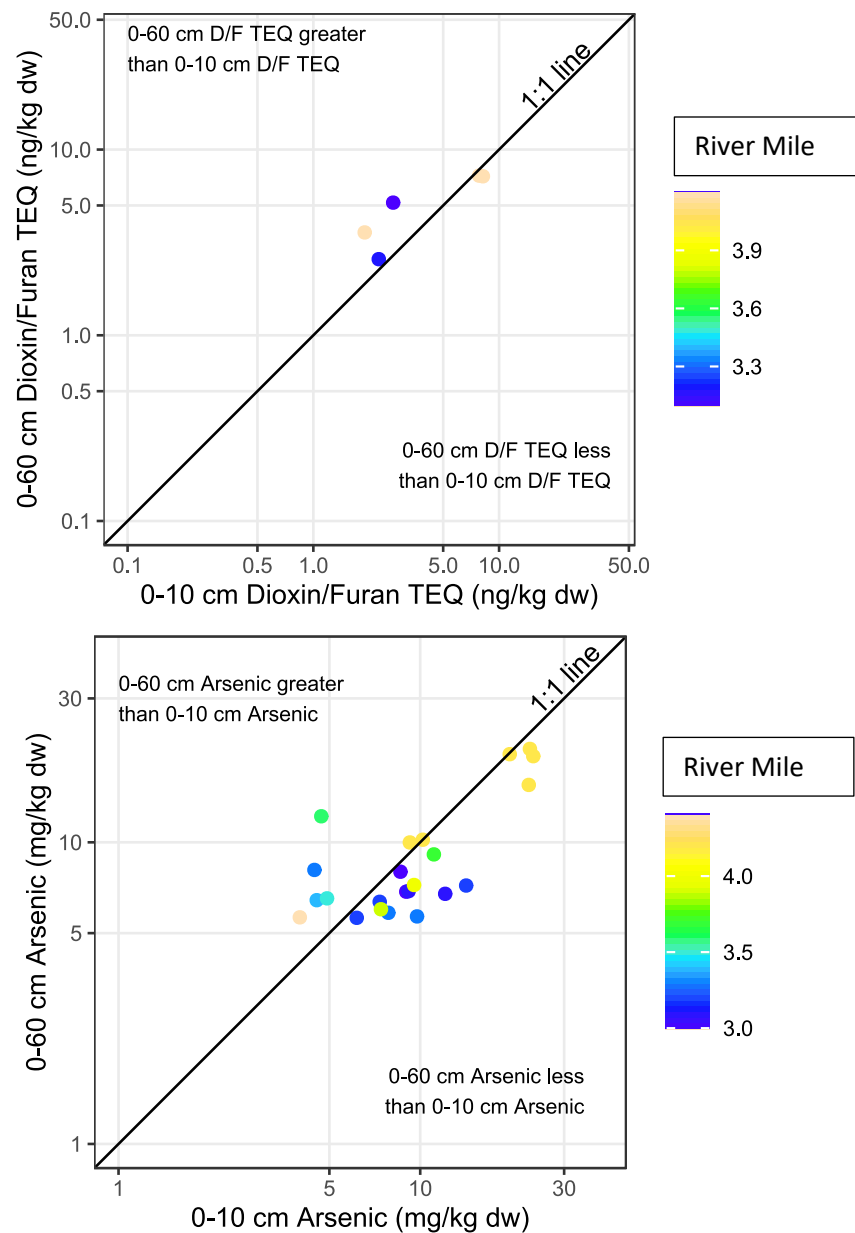
Scatterplots of Total PCB Aroclor Concentrations and cPAH TEQ Values in Surface (0–10 cm) Versus Subsurface Sediment (0–60 cm) in the Subtidal



Points color coded by river mile. Black line is the 1:1 line – points above this line have subsurface concentrations greater than those in the surface.

Figure D-4

Scatterplot of Dioxin/Furan TEQ Values and Arsenic Concentrations in Surface (0–10 cm) Versus Subsurface Sediment (0–60 cm) in the Subtidal



Points color coded by river mile. Black line is the 1:1 line – points above this line have subsurface concentrations greater than those in the surface.

4 Paired Data

The paired data are provided in Table D-1. Mean and median concentrations for the two intervals are shown to indicate central tendencies and data skewness. The remedial action levels (RALs) are provided for context.

Table D-1
Number Of Locations with Both Surface and Subsurface Sediment Samples with Median and Mean Concentrations in Each Sampling Interval

COC	Summary Statistic	Paired Intertidal Sediment		Paired Subtidal Sediment	
		Surface Sediment (0–10 cm)	Intertidal Sediment (0–45 cm)	Surface Sediment (0–10 cm)	Subtidal Sediment (0–60 cm)
Total PCB Aroclors (µg/kg dw)	Sample size Median Mean RAL	N = 75 78.0 214 240 at 2% TOC (12 mg/kg OC)	N = 75 101 349 1,300 at 2% TOC (65 mg/kg OC)	N = 56 74.8 79.2 240 at 2% TOC (12 mg/kg OC)	N = 56 131 191 240 or 3,900 at 2% TOC (12 mg/kg OC [RC 1 areas] or 195 mg/kg OC [RC2 and RC3 in potential vessel scour areas])
cPAH TEQ (µg/kg dw)	Sample size Median Mean RAL	N = 36 56.1 209 1,000 in ROD and 5,500 in cPAH ESD (EPA 2021)	N = 36 54.0 177 900 in ROD and 5,900 in cPAH ESD (EPA 2021)	N=24 65.4 76.9 1,000 in ROD and 5,500 in cPAH ESD (EPA 2021)	N=24 109.5 118 1000 in ROD in RC1 and 5,500 in cPAH ESD (EPA 2021)
Dioxin/furan TEQ (ng/kg dw)	Sample size Median Mean RAL	N = 32 4.29 7.20 25	N = 32 3.97 18.6 28	N = 5 2.69 4.56 25	N = 5 5.18 5.15 25 in RC1
Arsenic (mg/kg dw)	Sample size Median Mean RAL	N = 59 9.67 10.4 57 in RC1	N = 59 7.83 8.62 57 in RC1	N = 23 9.15 10.6 57 in RC 1	N = 23 7.19 9.36 57 in RC1

Notes:

COC: contaminant of concern

cPAH: carcinogenic polycyclic aromatic hydrocarbon

dw: dry weight

ESD: explanation of significant differences

OC: organic carbon

PCB: polychlorinated biphenyl

RAL: remedial action level
RC1: Recovery Category 1
RC2: Recovery Category 2
RC3: Recovery Category 3
ROD: Record of Decision
TEQ: toxic equivalent
TOC: total organic carbon

5 References

EPA. 2021. Proposed explanation of significant differences. Draft for public comment. Lower Duwamish Waterway Superfund site. US Environmental Protection Agency Region 10, Seattle, WA.